

Jonckheere Double Star Photometry – Part IV: Cetus

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Abstract: If any double star discoverer is in urgent need of photometry then it is Jonckheere. There are over 3000 Jonckheere objects listed in the WDS catalog and a good part of them have magnitudes which are obviously far too bright. This report covers the Jonckheere objects in the constellation Cet. Only one image per object was taken as despite the risk of random effects even a single measurement is better than the currently usually given estimation although the J-objects in this southern constellation are better covered with observations as usual for Jonckheere doubles.

Preamble

This report in no way intends to belittle the work of Jonckheere – on the contrary: He was obviously a very dedicated and able double star observer fighting with a lot of obstacles up to equipment destroyed in war. It seems that the basic double star parameters, RA/Dec coordinates and separation as well as position angle, were his main concern and the estimation of magnitudes was rather a side aspect to him. The often crass over estimation of magnitudes may also be a side effect of his obviously extraordinary eyesight.

Introduction

The degree of contamination of the WDS catalog with wrong magnitude data is rather high – this might very well be a side effect of magnitudes considered being not as important as the basic double star parameters separation and position angle. Measurements of magnitudes without these basic parameters are not even counted as observations in the WDS catalog. As follow up to the report on J-objects so far I selected this time all J-objects in Cet to be imaged for measurements with iT27 located in Australia due to the low altitude. The number of objects is with ~20 rather small so I decided to have also a look at other catalogs like SDSS, URAT1 and GAIA DR1 with recent position data if available for the objects in question for counter-checking. This should compensate also for the questionable quality of some of the taken images.

Results of Photometry and Catalog Checking

For each of the selected J-objects one single image was taken with iTelescope iT27 with V-filter and 3s exposure time, plate solved with Astrometrica using the UCAC4 (or if available URAT1) catalog with reference stars in the Vmag range of 10.5 to 14.5 giving not only RA/Dec coordinates but also photometry results for all reference stars used including an average dVmag error. The J-objects were then located in the center of the image and photometry was then done by the rather comfortable Astrometrica procedure with point and click at the components delivering Vmag measurements based on all reference stars used for plate solving.

The results are given in Table 1 with the following structure:

- The header line gives the WDS catalog data for each object per 08/2016 with RA/Dec in the HH:MM:SS/DD:MM:SS format and Date giving the date of the last observation
- The following rows give the data for the object in existing catalogs as far as available with
 - ◊ RA/Dec in decimal degrees with the catalog reference given in the Source/Notes column
 - ◊ Estimated visual M1 and M2 for 2MASS objects calculated from J- and K-band magnitudes if available
 - ◊ Visual M1 and M2 for URAT1 objects if available

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- ◊ Used Aperture and observation method code is given in the Ap and Me columns. As GAIA uses a rectangular aperture the value given in the Ap column is the calculated diameter for a corresponding circular surface
- ◊ Date gives the Bessel observation epoch
- ◊ If 2MASS and URAT1 or GAIA DR1 positions are available then also proper motion data is calculated (using the formulas provided by Buchheim – 2008 to determine proper motion vector direction and proper motion vector length) and checked for potential common proper motion with the CPM rating procedure according to Knapp and Nanson 2016. With the new GAIA DR1 data several objects qualify now for common proper motion pairs – in all cases with a relationship of Sep/PM of far less than 1000 years, in most cases even less than 100 years indicating a high probability of being real
- The last row gives then the measurements based on the iT27 images
 - ◊ RA/Dec in decimal degrees from plate solving
 - ◊ Sep and PA are calculated from the RA/Dec coordinates in degrees using the formulas provided by Buchheim - 2008
 - ◊ Visual magnitudes M1 and M2 based on the plate solving results
 - ◊ Error estimations calculated on base of the average plate solving errors are given in the Notes column
- AstroPlanner v2.2
- iTelescope iT27: 700mm CDK with 4531mm focal length. CCD: FLI PL09000. Resolution 0.53 arcsec/pixel. V-filter. Siding Spring, Australia. Elevation 1122m
- GAIA DR1 catalog
- MaxIm DL6 v6.08
- POSS images
- SDSS DR9 and DR7 catalogs
- SDSS images
- SIMBAD
- UCAC4 catalog
- URAT1 catalog
- VizieR
- Washington Double Star Catalog

References

- Buchheim, Robert, 2008, "CCD Double-Star Measurements at Altimira Observatory in 2007", *Journal of Double Star Observations*, **4**, 27-31.
- Knapp, Wilfried; Nanson, John, 2017, "A New Concept for Counter-Checking of Assumed CPM Pairs", *Journal of Double Star Observations*, **13**, 31-51.

Summary

Table 1 shows with few exceptions significant differences for the magnitudes compared with the WDS data even if the J-objects in Cet seem rather well researched in comparison with northern constellations. A surprisingly high percentage of the objects qualify as CPM pairs based on calculations with the now available GAIA DR1 data.

Acknowledgements:

The following tools and resources have been used for this research:

- 2MASS catalog
- 2MASS images
- AAVSO APASS (via the UCAC4 catalog)
- AAVSO VPhot
- Aladin Sky Atlas v9.0
- Astrometrica v4.10.0.427

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Table 1. J Objects in Cetus

J#	RA	Dec	Sep"	PA°	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spcl	Spcl2	Ap	Me	Date	CFM Rat	Source/Notes
302	00:150:23.480	-01:105:55.9	4.4	71.0	10.91	11.90	12	-14		26	-11		F2		2.5	Es	2000		WD800508-0052 values per 08/2016
	12.59784200	-1.0988670	4.38	70.2													2003.809		SDSS DR9
	12.59790417	-1.0989194	3.89	67.2	10.47	12.19									0.7	C	2016.023		it27 1x3s/UCAC4. Touching star disks, image quality not very good. Err_Sep 0.297", Err_PA 4.364", Err_Mag 0.105/0.109
																			Despite the clear elongation in the 2MASS images indicating touching star disks there is no 2MASS catalog object for B, the same goes for URAT1 and GAIA DRI
303	03:04:50.230	+08:06:49.0	3.0	38.0	10.29	11.83	2	3					F8				2010		WD803046+0807 values per 08/2016
	46.20931621	8.1136483	3.01	39.9											0.96	Hg	2015		GAIA DRI
	46.20929583	8.1137528	2.46	39.4	10.41	11.08									0.7	C	2016.024		it27 1x3s/URAT1. Touching/Overlapping star disks. Err_Sep 0.234", Err_PA 5.445", Err_Mag 0.082/0.088
304	03:21:34.880	+08:04:35.0	4.3	85.0	10.84	11.50	2	-23		-12	-11		G5				2014		WD803214+0803 values per 08/2016
	50.39532800	8.0764200	4.55	84.0	10.78	12.02									1.3	E2	2000.019		2MASS. M1/M2 estimated from J- and K-band
	50.39546440	8.0763144	4.41	84.0	10.33		35.84	-28.02	12.55	25.63	-28.28	12.42	G3		0.2	Eu	2013.658	CCC	URAT1. PM data calculated from position comparison with 2MASS - not obviously CFM pair. Spc according to B-V color index
	50.39546010	8.0763076	4.54	83.7			31.43	-27.00	11.37	30.76	-25.38	11.37			0.96	Hg	2015	AAC	GAIA DRI. PM data calculated from position comparison with 2MASS suggests CFM despite the rather large 2MASS position error
	50.39547500	8.0763194	4.41	86.2	10.54	12.12									0.7	C	2016.024		it27 1x3s/URAT1. Err_Sep 0.120", Err_PA 1.566", Err_Mag 0.090/0.091
648	02:28:55.340	+00:43:17.2	2.5	157.0	10.70	11.00											2001		WD802289+0044 values per 08/2016
	37.23044900	0.7216480	2.83	155.1											2.5	Es	1998.878		SDSS DR9. A and B same observation date
	37.23043800	0.7216520	2.82	155.9											2.5	Es	2000.904		SDSS DR9. A and B same observation date
	37.23041900	0.7216470	2.77	151.6											2.5	Es	2001.723		SDSS DR9. A and B same observation date
	37.23041700	0.7216150	2.44	158.4											2.5	Es	2001.890		SDSS DR7
	37.23042900	0.7216070	2.53	154.9											2.5	Es	2004.841		SDSS DR9. A and B same observation date
	37.23044000	0.7216330	2.66	157.5											2.5	Es	2004.861		SDSS DR9. A and B same observation date
	37.23036853	0.7215815	2.74	155.5			-17.97	-14.84	5.99	-21.19	-10.20	5.99			0.96	Hg	2015	CAC	GAIA DRI. PM data calculated from position comparison with SDSS DR9 1998.878 suggests not CFM
	37.23036250	0.7216250	2.34	154.1	10.53	10.96									0.7	C	2016.023		it27 1x3s/URAT1. Err_Sep 0.219", Err_PA 5.367", Err_Mag 0.092/0.095
																			The spread within the SDSS measurements is amazing

Table 1 continues on next page.

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Table 1. J Objects in Cetus

J#	RA	Dec	Sep ¹	PA ^o	M1	M2	pmA1	pmDec1	e _{pm1}	pmA2	pmDec2	e _{pm2}	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
1252	03:02:08.210	+07:09:42.0	4.6	269.0	11.98	12.17	21	-2		-23	3				1.3	E2	2014		WDS03021+0710 values per 08/2016
	45.53424900	7.1616660	4.59	269.2	11.84	11.91											1999.932		2MASS. M1/M2 estimated from J- and K-band
	45.53424330	7.1616564	4.60	269.1			-1.46	-2.47	10.31	-2.00	-3.29	10.22			0.2	Eu	2013.980	ACC	URAT1. PM data calculated from position comparison with 2MASS, values too small to be significant
	45.53424981	7.1616565	4.62	268.9			0.19	-2.28	9.57	-1.70	-4.03	9.57			0.96	Hg	2015	CCC	GATA DR1. PM data calculated from position comparison with 2MASS suggests not CPM
	45.53428750	7.1617139	5.17	264.5	12.04	12.11									0.7	C	2016.023		IT27 1x3s/URAT1. Average position error after plate solving rather large. Err_Sep 0.391", Err_PA 4.324", Err_Mag 0.112/0.112
1432	00:11:01.280	-06:26:24.2	7.2	274.0	11.10	12.70	-8	-13		-40	-4						1999		WDS00110-0627 values per 08/2016
	2.75534000	-6.4400870	7.25	274.4	10.84	12.48									1.3	E2	1998.790		2MASS. M1/M2 estimated from J- and K-band
	2.75533100	-6.4400910	7.34	273.8			-4.06	-1.82	26.36	-16.26	-11.82	26.36			2.5	Es	2006.711	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values do not suggest CPM
	2.75528054	-6.4401229	7.17	274.0			-21.78	-13.86	13.73	-0.91	-11.55	13.73			0.96	Hg	2015	CCC	GATA DR1. PM data calculated from position comparison with SDSS9 - not CPM
	2.75525000	-6.4400583	7.16	274.6	10.85	12.65									0.7	C	2016.029		IT27 1x3s/UCAC4. Err_Sep 0.184", Err_PA 1.470", Err_Mag 0.071/0.072
1436 AB	00:33:37.360	-16:55:42.7	6.1	113.0	10.70	11.70	-77	-47		10	-84						2008		WDS00336-1656 values per 08/2016
	8.40566600	-16.9285220	6.10	113.3	11.22	11.82									1.3	E2	1999.604		2MASS. M1/M2 estimated from J- and K-band
	8.40556800	-16.9286470	5.99	112.5			-47.27	-63.02	14.01	-55.95	-46.39	14.01			2.5	Es	2006.744	CBC	SDSS DR9. PM data calculated from position comparison with 2MASS, values do rather not suggest CPM
	8.40543534	-16.9287133	6.05	113.2			-51.60	-44.73	6.50	-54.10	-42.94	6.50			0.96	Hg	2015	AAB	GATA DR1. PM data calculated from position comparison with 2MASS suggests solid CPM
	8.40530833	-16.9288139	6.20	111.1	11.10	11.82									0.7	C	2016.023		IT27 1x3s/UCAC4. Err_Sep 0.262", Err_PA 2.425", Err_Mag 0.091/0.093
1436 AC	00:33:37.360	-16:55:42.7	23.9	72.0	10.70	11.18	-77	-47		78	-88						2008		WDS00336-1656 values per 08/2016
	8.40566600	-16.9285220	23.03	70.7	11.22	11.27									1.3	E2	1999.604		2MASS. M1/M2 estimated from J- and K-band
	8.40556800	-16.9286470	23.77	72.2			-47.27	-63.02	14.01	78.62	-111.93	14.01			2.5	Es	2006.744	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest optical pair. Different PM direction causes Sep and PA change over time
	8.40543534	-16.9287133	24.68	74.0			-51.60	-44.73	6.50	77.01	-96.65	6.50			0.96	Hg	2015	CCB	GATA DR1. PM data calculated from position comparison with 2MASS suggests not CPM
	8.40530833	-16.9288139	24.91	73.8	11.10	11.21									0.7	C	2016.023		IT27 1x3s/UCAC4. Err_Sep 0.262", Err_PA 0.604", Err_Mag 0.091/0.091
1438	00:46:12.600	-05:14:17.1	5.8	348.0	12.10	12.30	57	10		59	14						1999		WDS00462-0514 values per 08/2016
	11.55250300	-5.2380810	5.77	347.2	11.73	11.90									1.3	E2	1998.746		2MASS. M1/M2 estimated from J- and K-band
	11.55268900	-5.2380620	5.82	347.4			65.05	6.67	8.28	65.75	11.59	8.28			2.5	Es	2008.997	BAC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest to some degree CPM
	11.55277602	-5.2380473	5.81	347.5			60.22	7.46	5.22	61.56	10.08	5.22			0.96	Hg	2015	AAB	GATA DR1. PM data calculated from position comparison with 2MASS suggests solid CPM
	11.55275000	-5.2381750	5.56	348.5	11.88	12.09									0.7	C	2016.023		IT27 1x3s/UCAC4. Huge average position error after plate solving suggests fast PM of several reference stars or very bad image. Err_Sep 0.262", Err_PA 0.604", Err_Mag 0.091/0.091
1441	00:53:24.610	-05:45:20.6	7.5	334.0	10.40	12.40	-19	-37		-18	-37		G0				2014		WDS00534-0545 values per 08/2016
	13.35259700	-5.7557320	7.54	335.0	10.18	11.78									1.3	E2	1998.823		2MASS. M1/M2 estimated from J- and K-band
	13.35251500	-5.7557930	7.41	334.5			-28.87	-21.58	10.63	-28.52	-36.44	10.63			2.5	Es	2008.997	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	13.35249912	-5.7558880	7.50	334.5			-21.67	-34.72	6.69	-24.35	-38.84	7.05			0.96	Hg	2015	ACC	GATA DR1. PM data calculated from position comparison with 2MASS. Potential CPM - difference in PM vector length might suggest an orbit
	13.35239167	-5.7557889	7.75	335.2	10.03	11.66									0.7	C	2016.023		IT27 1x3s/UCAC4. Huge average position error after plate solving suggests fast PM of several reference stars or very bad image. Err_Sep 0.587", Err_PA 0.433", Err_Mag 0.101/0.103

Table 1 continues on next page.

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Table 1. J Objects in Cetus

J#	RA	Dec	Sep"	PA°	M1	M2	pmRA1	pmDec1	e_fm1	pmRA2	pmDec2	e_fm2	Spcl	SpC2	Ap	Me	Date	CPM Rat	Source/Notes
1444 AB	01:19:10.760	-04:39:24.9	6.9	190.0	10.13	14.80	26	0	-36	-29						1999			WDS01192-0439 values per 08/2016
	19.79483300	-4.6569920	6.50	184.9	9.97	14.00									1.3	E2	1998.714		2MASS, MI/M2 estimated from J- and K-band
	19.79493600	-4.6569180	6.94	182.6			35.94	25.91	8.25	59.67	-18.55	8.25			2.5	Es	2008.997	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	19.79496845	-4.6569249	6.92	182.3			30.04	14.93	6.69	47.44	-12.42	6.69			0.96	Hg	2015	CCC	GAIADR1. PM data calculated from position comparison with 2MASS suggests not CPM
	19.79483333	-4.6569639	6.29	184.9	9.94	14.54									0.7	C	2016.023		IT27 Ix3s/UCAC4. Image quality questionable. Err_Sep 0.342", Err_PA 3.111", Err_Mag 0.080/0.139
1444 AC	01:19:10.760	-04:39:24.9	51.0	168.0	10.13	11.80	26	0	2	4						2013			WDS01192-0439 values per 08/2016
	19.79483300	-4.6569920	51.06	167.0	9.97	12.43									1.3	E2	1998.714		2MASS, MI/M2 estimated from J- and K-band
	19.79493600	-4.6569180	51.06	167.3			35.94	25.91	8.25	9.42	18.90	8.25			2.5	Es	2008.997	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	19.79496845	-4.6569249	50.99	167.5			29.84	14.83	5.21	4.42	13.11	5.21			0.96	Hg	2015	CCC	GAIADR1. PM data calculated from position comparison with 2MASS suggests not CPM
	19.79483333	-4.6569639	50.91	167.6	9.94	12.38									0.7	C	2016.023		IT27 Ix3s/UCAC4. Image quality questionable. Err_Sep 0.342", Err_PA 0.385", Err_Mag 0.080/0.083
1444 CD	01:19:11.530	-04:40:14.8	8.6	89.0	11.80	11.90	2	4	11	9						2013			WDS01192-0439 values per 08/2016
	19.79803600	-4.6708100	8.50	88.4	12.43	12.80									1.3	E2	1998.714		2MASS, MI/M2 estimated from J- and K-band
	19.79806300	-4.6707560	8.59	88.6			9.42	18.90	8.25	18.84	15.40	8.25			2.5	Es	2008.997	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values too small to suggest CPM
	19.79805607	-4.6707507	8.64	88.7			4.42	13.11	5.21	13.10	10.26	5.21			0.96	Hg	2015	CCC	GAIADR1. PM data calculated from position comparison with 2MASS - values too small to suggest CPM
	19.79789167	-4.6707722	8.70	89.4	12.38	12.87									0.7	C	2016.023		IT27 Ix3s/UCAC4. Image quality questionable. Err_Sep 0.587", Err_PA 2.251", Err_Mag 0.083/0.088
1446	01:27:24.290	-02:04:10.8	10.6	143.0	10.05	13.20	-32	-24	-24	-42						1999			WDS01274-0204 values per 08/2016
	21.85124800	-2.0671810	10.63	143.2	10.06	12.43									1.3	E2	1998.719		2MASS, MI/M2 estimated from J- and K-band
	21.85112100	-2.0672180	10.61	142.7			-45.19	-13.17	15.64	-39.50	-5.70	15.64			2.5	Es	2008.830	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	21.85111826	-2.0672753	10.57	143.0			-28.67	-20.85	9.71	-29.09	-16.48	9.71			0.96	Hg	2015	CBC	GAIADR1. PM data calculated from position comparison with 2MASS - values too small to suggest CPM. Yet comparison POSS I and II images show very well a quite similar if small proper motion
	21.85103333	-2.0672694	10.55	141.9	9.79	12.37									0.7	C	2016.023		IT27 Ix3s/UCAC4. Image quality questionable. Err_Sep 0.331", Err_PA 1.799", Err_Mag 0.090/0.093
1447	01:39:31.580	-06:11:53.8	3.3	207.0	11.50	11.60	29	64	-14	-16			K4			2004			WDS01395-0612 values per 08/2016
	24.88156500	-6.1982820	2.60	204.5	9.97	10.33									1.3	E2	1998.815		2MASS, MI/M2 estimated from J- and K-band
	24.88159500	-6.1981860	3.40	205.9			10.50	33.79	13.90	-29.39	-33.44	18.68			2.5	Es	2009.044	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	24.88158178	-6.1981973	3.23	206.0			3.71	18.83	9.77	-17.19	-14.05	9.77			0.96	Hg	2015	CCC	GAIADR1. PM data calculated from position comparison with 2MASS - values suggest not CPM
	24.88158750	-6.1983389	2.95	207.4	10.95	11.02									0.7	C	2016.023		IT27 Ix3s/UCAC4. Image quality questionable. Err_Sep 0.201", Err_PA 3.902", Err_Mag 0.093/0.093
1448 AB	01:45:32.210	-02:24:13.1	8.0	150.0	11.60	13.20	62	14	11	-17			G8			1999			WDS01456-0224 values per 08/2016
	26.38419700	-2.4036300	8.09	150.9	11.32	12.71									1.3	E2	1998.728		2MASS, MI/M2 estimated from J- and K-band
	26.38420600	-2.4038660	7.53	146.9			3.20	-84.09	9.13	20.65	-8.20	9.13			2.5	Es	2008.831		SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	26.38418810	-2.4039453	7.34	145.7			-2.16	-76.55	6.22	11.50	-8.37	6.29			0.2	Eu	2013.474	CCC	URAT1. PM data calculated from position comparison with 2MASS, values suggest not CPM
	26.38418597	-2.4039822	7.25	145.1			-2.44	-77.91	5.67	10.24	-9.06	5.67			0.96	Hg	2015	CCC	GAIADR1. PM data calculated from position comparison with 2MASS - values suggest not CPM
	26.38414583	-2.4040167	7.34	143.4	11.20	12.65									0.7	C	2016.023		IT27 Ix3s/URAT1. Err_Sep 0.113", Err_PA 0.883", Err_Mag 0.110/0.112

Table 1 continues on next page.

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Table 1. *J* Objects in *Cetus*

J#	RA	Dec	Sep ⁿ	PA°	M1	M2	pmRA1	pmDec1	e_pm1	pmRA2	pmDec2	e_pm2	Spc1	Spc2	Ap	Me	Date	CPM Rat	Source/Notes
1448 BC	01:45:32.470	-02:24:20.1	14.4	257.0	13.20	12.80	11	-17		-10	-11						1999		WDS01456-0224 values per 08/2016
	26.38529200	-2.4055940	14.37	257.6	12.71	11.77									1.3	E2	1998.728		2MASS. M1/M2 estimated from J- and K-band
	26.38535000	-2.4056170	14.70	254.9			20.65	-8.20	9.13	4.98	-81.24	9.13			2.5	Es	2008.831		SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	26.38533890	-2.4056281	14.79	254.0			11.50	-8.37	6.29	-0.44	-75.06	6.22			0.2	Eu	2013.468	CCC	URAT1. PM data calculated from position comparison with 2MASS, values suggest not CPM
	26.38533833	-2.4056350	14.82	253.6			10.24	-9.06	5.67	-1.05	-75.94	5.67			0.96	Hg	2015	CCC	GATA DRI. PM data calculated from position comparison with 2MASS - values suggest not CPM
	26.38536250	-2.4056528	14.83	254.3	12.65	11.64									0.7	C	2016.023		IT27 1x3s/URAT1. Err_Sep 0.113", Err_PA 0.437", Err_Mag 0.112/0.111
1449 AB	01:58:55.780	-09:48:41.6	8.6	328.0	11.70	13.20	-21	-32		16	4						2010		WDS01588-0949 values per 08/2016
	29.73243700	-9.8116200	8.39	323.1	11.46	12.14									1.3	E2	1998.810		2MASS. M1/M2 estimated from J- and K-band
	29.73242700	-9.8116260	8.38	323.0			-18.40	-11.20	55.14	-20.24	-18.67	55.14			2.5	Es	2000.738		SDSS DR9. Time frame far too short to get reliable pm data from comparison with 2MASS
	29.73235460	-9.8117511	8.44	328.1	11.18		-19.37	-31.27	7.04	19.41	-0.81	7.03			0.2	Eu	2013.912	CCC	URAT1. PM data calculated from position comparison with 2MASS, values suggest not CPM
	29.73235792	-9.8117474	8.45	328.6			-17.33	-28.32	6.57	22.00	2.48	6.57			0.96	Hg	2015	CCC	GATA DRI. PM data calculated from position comparison with 2MASS, values suggest not CPM
	29.73232917	-9.8117500	8.43	328.5	11.41	12.19									0.7	C	2016.023		IT27 1x3s/URAT1. Err_Sep 0.114", Err_PA 0.775", Err_Mag 0.071/0.071
1450 AB	02:05:24.77	-09:47:31.1	5.9	1.0	10.18	10.48	147	-37		147	-38		K2				2009		WDS02054-0947 values per 08/2016
	31.35321300	-9.7920010	6.06	2.5	10.18	10.28									1.3	E2	2000.803		2MASS. M1/M2 estimated from J- and K-band
	31.35322600	-9.7919970	5.94	2.5											2.5	Es	2000.738		SDSS DR9. Time frame far too short to get reliable pm data from comparison with 2MASS
	31.35376310	-9.7921044	6.19	2.2			148.48	-28.32	17.38	146.26	-18.79	17.43			0.2	Eu	2013.928	BAC	URAT1. PM data calculated from position comparison with 2MASS, values suggest CPM despite some difference in the pm vector direction and a rather large 2MASS position error range
	31.35382135	-9.7921045	6.14	2.1			152.01	-26.23	16.09	149.04	-20.68	16.09			0.96	Hg	2015	AAC	GATA DRI. PM data calculated from position comparison with 2MASS, values suggest CPM
	31.35384583	-9.7920694	6.05	1.0	10.17	10.52									0.7	C	2016.023		IT27 1x3s/URAT1. Err_Sep 0.214", Err_PA 2.026", Err_Mag 0.080/0.080
1451 AB	02:29:14.950	-07:13:24.6	5.4	172.0	11.00	12.40	-23	3		-7	-10						2004		WDS02292-0712 values per 08/2016
	37.31226000	-7.2235650	5.44	171.1	10.83	12.04									1.3	E2	1998.761		2MASS. M1/M2 estimated from J- and K-band
	37.31223100	-7.2235710	5.33	172.2											2.5	Es	2000.882		SDSS DR9. Time frame far too short to get reliable pm data from comparison with 2MASS
	37.31211080	-7.2235436	5.36	171.4	10.48		-35.09	5.07	9.15	-37.46	9.46	9.11			0.2	Eu	2013.979	CBC	URAT1. PM data calculated from position comparison with 2MASS, values suggest rather not CPM
	37.31212070	-7.2235341	5.44	171.9			-30.64	6.86	8.55	-35.27	6.09	8.55			0.96	Hg	2015	ACC	GATA DRI. PM data calculated from position comparison with 2MASS, values suggest despite very similar pm vector direction rather not CPM as pm vector length is too short to be significant
	37.31212917	-7.2235611	5.22	172.3	10.71	12.03									0.7	C	2016.023		IT27 1x3s/URAT1. Err_Sep 0.175", Err_PA 1.917", Err_Mag 0.100/0.101
1900 AB	01:18:47.720	-03:17:43.5	4.0	191.0	9.50	10.40	15	96		-12	-38						2013		WDS01188-0318 values per 08/2016
	19.69886800	-3.2954280	3.97	191.6	11.25	11.87									1.3	E2	1998.714		2MASS. M1/M2 estimated from J- and K-band
	19.69882700	-3.2953740	4.03	192.6			-14.57	19.22	13.44	-22.03	15.30	13.44			2.5	Es	2008.830	CCC	SDSS DR9. PM data calculated from position comparison with 2MASS, values suggest not CPM
	19.69882384	-3.2953495	3.98	191.0			-9.75	17.36	8.35	-6.98	16.68	8.35			0.96	Hg	2015	CBC	GATA DRI. PM data calculated from position comparison with 2MASS, values suggest not CPM
	19.69884167	-3.2951306	4.10	188.4	10.89	11.71									0.7	C	2016.023		IT27 1x3s/URAT1. Err_Sep 0.294", Err_PA 4.099", Err_Mag 0.121/0.124

Table 1 continues on next page.

Jonckheere Double Star Photometry – Part IV: Cet

Table 1 Explanations Notes column:

- “iT27 1x3s/URAT1 or UCAC4” indicates the use of telescope iT27 images with 3s exposure time and use of URAT1 or UCAC4 for plate solving
- „Err_Sep ", Err_PA °, Err_Mag M1/M2“ gives the error estimations calculated as $\text{Err_Sep} = \text{SQRT}(d\text{RA}^2 + d\text{Dec}^2)$ with $d\text{RA}$ and $d\text{Dec}$ as average RA and Dec plate solving errors, $\text{Err_PA} = \arctan(\text{Err_Sep}/\text{Sep})$ assuming the worst case that Err_Sep points perpendicular to the separation vector and $\text{Err_Mag} = \text{SQRT}(d\text{Vmag}^2 + (2.5 * \text{LOG}_{10}(1 + 1/\text{SNR}))^2)$ with $d\text{Vmag}$ as average Vmag plate solving error and SNR as signal to noise ratio for the given object
- “Touching star disks” indicates that the rims of the star disks are touching and that the measurement results might be a bit less precise than with clearly separated star disks
- “Touching/Overlapping star disks” indicates that the star disks overlap to the degree of an elongation and that the measurement results is probably less precise than with clearly separated star disks
- “SNR <20” indicates that the measurement result might be a bit less precise than desired due to a low SNR value but this is already included in the calculation of the magnitude error range estimation
- “SNR <10” indicates that the measurement result is probably a bit less precise than desired due to a very low SNR value but this is already included in the calculation of the magnitude error range estimation
- “Image quality questionable” or similar indicates rather large average errors for the reference stars used for plate solving for different reasons. But this is already included in the calculation of the error range estimation

